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Toward a Taxonomy of City Logistics Projects

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Abstract. We present a three-layer taxonomy of City Logistics projects that provides the means to explore the similarities and differences in the elements characterizing the various City Logistics initiatives as a step towards better understanding their performances, as well as to identify trends in the evolution of City Logistics. To illustrate its interest, the taxonomy is used to describe well-known systems and identify a number of trends in City Logistics evolution.

Keywords. City Logistics, classification.

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INTRODUCTION

Urban population is steadily increasing (OCDE, 2003) and cities around the word have to respond to continuously increasing requirements in terms of efficient movement of persons and goods, while controlling, reducing, ideally, the negative impacts of transportation, e.g., congestion and pollution, on the quality of life of their citizens. Freight transportation makes a significant contribution both to the support of city life under all its aspects and to the deterioration of traffic condition and environment quality. The *City Logistics* concept has emerged as a new, comprehensive way to address this issue and mitigate the negative effects of increasing freight volumes moving in cities, while not penalizing the city's many activities: economic, social, administrative, cultural, touristic, and so on.

The nineties have seen a significant increase in the general awareness regarding the urban freight transport effects on the city and its habitants. A good number of City Logistics initiatives, henceforth identified as City Logistics Projects (CLPs), have subsequently been undertaken, mainly in Western Europe and Japan in early nineties (Dablanc, 2003). Numerous projects have been contemplated or undertaken since, both in these initial regions and elsewhere around the world.

As most logistics-related decisions were (and are) made on the basis of the experience and intuition of experts, skilled operators and planners (Taniguchi *et al.*, 2006), these CLPs experimented with various business and organizational models. In Germany (and some cities in Switzerland), private companies were the initiators of CLPs, the public authorities providing little support (Visser *et al.*, 1999). In Japan and The Netherlands, the City Logistics concept found more support from governments and city councils, public authorities stimulating the projects by offering subsidies, assuming part of expenditures, or favouring participating companies. In Monaco and France, urban distribution is considered as a public service and the CLPs had a complete support from the government. Success has been varied. Thus, for example, from the approximately 200 projects either planned or carried out in Germany during this period, less than 15 were still in existence by the end of 2002 (Browne *et al.*, 2005). "Success" was also more marked for small to medium cities than for large ones. New projects are being proposed, however, revisiting "traditional" models and experimenting with new ones.

It is not without interest to explore in some depth the similarities and differences in the elements characterizing the various CLPs as a step towards better understanding the reasons behind these results, as well as identifying trends in the evolution of CLPs and the way decision-makers design, evaluate, and operate the projects. The time is particularly right given the steady development of CLPs observed in the traditional City Logistics strongholds of Western Europe and Japan, and the effervescence one observes elsewhere.

At our best knowledge, there are no classifications of CLPs in the literature that provide a systemic and complete understanding of these issues. The few contributions one may found often use criteria, e.g., "based on Urban Distribution Centre" or "based on carrier cooperation" that are much too aggregated for a comprehensive analysis. Moreover, factors not often used in the first wave of City Logistics projects, e.g., integration of Intelligent Transportation Systems concepts and technology or the utilization of advanced methodologies and instruments for analysis, planning, and management, do not appear in most published classifications. This makes it difficult to

identify major characterizing factors, to point to evolution in concepts and practice, to single out and understand success factors, to extract and analyze trends.

The goal of this paper is to contribute to fill this gap by introducing a taxonomy of City Logistics projects based on a comprehensive set of parameters providing the means to describe current and planned projects, identify relations between project characteristics, and analyze trends. The taxonomy is based on the analysis of a large number of CLPs undertaken around the world and is organized according to three increasingly more detailed levels: five *components*, each being structured at the second level through a number of *criteria*, for which more precise information is given at the third level by *items*.

The paper is organized as follows. The next section presents our methodology, including a brief review of previous classification efforts and the description of the sample of some 70 CLPs used to define our classification rules. The taxonomy is detailed next. To illustrate the interest of the proposed taxonomy, we then describe two well-known CLPs in Monaco and Amsterdam, followed by a discussion of emerging trends in CLPs.

METHODOLOGY

A first issue to be addressed in designing the taxonomy is the specification of its object: what are we trying to classify? We are not performing, for example, a survey of literature on City Logistics, although such a survey was part of the work. It also became rapidly apparent that a city-based classification is not satisfactory because, on one hand, several cities have experimented with various systems during the years and, on the other hand, several systems may exist simultaneously in the same (large) city. We thus decided on the *City Logistics Project* (CLP) as taxonomy unit, each representing a system proposed or implemented for a given city, or part thereof, and time period. A City Logistics system may evolve, of course, going, for example, from a study phase, to a pilot implementation, to a full-scale deployment. Due to their different characteristics detailed in the following section, such phases are presented as separate CPLs in the proposed taxonomy.

The second issue is the information required to specify the taxonomy. Several CLPs were undertaken around the word in the last twenty-something years. The level of information dissemination was very varied, however, and one of the challenges of the study reported in this paper was gathering the documentary records. We examined over one hundred projects and decided to restrict our study to the CLPs for which pertinent and useful information was available. The final set contains 70 CLPs undertook in 13 countries (Table 1) in the 1976-2007 period (Table 2).

We analysed qualitatively the information relative to the selected projects from the corresponding city and project websites, published papers and presentations, as well as governmental communications and consulting reports.

Table 1: Projects by Country

Country	Germany	Denmark	Spain	France	Holland	Italy	Japan
# Projects	13	2	5	9	8	8	4
Country	Norway	Portugal	U.K	Slovenia	Sweden	Switzerland	
# Projects	3	1	10	1	5	1	

Table 2: Project Launching Dates

Year	1976-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2005-2007
Number of projects	2	0	2	10	15	33	8

We then organized the information by categories and subcategories. We used the existing CLP classifications to orient our reflexion. We rapidly observed, however, that existing classifications did not allow for the level of description we were looking for. Thus, for example, Tanigushi *et al.* (1999) and Goldman and Gorham (2006) focused on the "functional tools" used to (re-) organize the urban freight distribution. The former used 5 city logistics "schemes", regulation, cooperative systems, intelligent transport systems, public freight terminal, and infrastructure provision, while the latter defined 4 families: neighbourhood drop-off points, centralized urban distribution and logistics centres, construction logistics, and environmental zones. We notice the lack of many aspects, legal, financial, technological, and so on, which can characterize CLPs.

A different and rather widespread classification consists of categorizing CLPs under 3 models: German, Dutch, and Monaco. On closer examination, it becomes rapidly evident, however, that this specification concerns almost exclusively the public support given to projects and to some extent their financing. Kohler (2001) focuses on cooperation among stakeholders and describes six forms for City Logistics in Germany, based essentially on how flows and responsibilities are divided among carriers. The website of the French "Ministère de l'Équipement" presents a description of French CLPs, based on six axes, general description, stakeholders, stages and evolution, management-financing and regulation, activities and finally transferability. Other than the geographical limitation of the last two classifications, one notices the absence of a number of factors, e.g., those related to information and decision technologies.

Browne *et al.* (2006) proposed a classification of CLPs with Urban Consolidation Centres (UCCs), also called Urban Distribution Centres (UDCs). Based on an analysis of factors influencing the nature of UCCs and the options available within each factor, the authors used 17 items for the classification, without gathering them into specific categories. More importantly, projects may be based on the same UCC organisation and still differ in many other important characteristics. Thus, associating all CLPs with UCCs into one category is too restrictive (Benjelloun and Crainic, 2008). Recently, Quack et *al.* (2008) independently developed and presented a richer set

of classification elements, which addressed several of these shortcomings. It still does not cover all relevant topics, however.

Therefore, based on the information available for the selected CLPs, as well as on a number of proposals in the literature not yet implemented in practice, we defined the taxonomy introduced in the next section.

TAXONOMY DIMENSIONS

We propose a taxonomy that describes projects according to three, increasingly more detailed levels. The first level is made up of five *components*, each component being structured at the second level through a number of *criteria* representing its subcategories, for which more precise information is given at the third level by *items*. The taxonomy has twenty-two criteria and seventy two items. This section presents each component in turn, briefly describing its object and scope, as well as its corresponding criteria and items. The five components are: 1) *Description*; 2) *Business model*; 3) *Functionality*; 4) *Scope*; and 5) *Technology*.

1. Description

Description gives the context explanation through five criteria: *Objectives* explains the desired future state. *Project status* provides indices on the evolution of the project (study, experimental, permanent). *Evaluation tools* refers to how the implementation decision is taken and how the impact on the urban freight transport system is measured. Finally, *stakeholders* and *project initiator* detail the participating entities and who, among the stakeholders actively involved, is taking the lead, respectively.

1.1 Objectives. Freight transportation critically contributes to traffic congestion, energy consumption, and negative environmental impacts. The major objective of City Logistics is to significantly mitigate the problem through sustainable freight transport systems. The main goals are to reduce energy consumption, pollution and traffic congestion. An economic objective may also be observed when companies are created to take advantage of business opportunities. The items thus are:

- *Economics*: Exploit business opportunities by creating a company or a dedicated department likely to produce a financial benefit;
- *Environmental*: Reduce the impact of urban freight movements on the environment, in particular its level of total emissions;
- *Congestion*: Reduce traffic congestion and its effects;
- *Energy consumption*: Reduce the energy consumed to transport the same quantity of commodities.

1.2 Status. City Logistics systems and projects may be in various stages. The first two refer to projects undertaking theoretical or practical analyzes for the design and viability of the system. The last two items concern the planed temporal horizon of the system:

- *Study*: Technical, legal, financial analyzes to determine and document system design, evaluation, implementation or abandonment;

- *Pilot/Experimental*: Pilot projects are used to find out if the considered solution can be implemented on a long-term basis;
- *Permanent*: The project is conceived to function on a long-term basis. Studies and have probably been performed to assess its probable success;
- *Temporary*: Conceived to function during a fixed period of time. Generally to mitigate the effect of a temporary event (e.g., building sites).

1.3 Evaluation tools for City Logistics initiatives. In many cases, decisions were taken on the basis of the experience or intuition of the decision makers. A formal process of evaluation is based on precise numerical objectives and procedures. Three items are defined corresponding to the most important established objectives:

- *Financial analysis*: The decision is based on the examination of a system's financial viability, profitability, solvability, etc.;
- *Traffic analysis*: The most commonly used indicators are changes in vehicle trips, vehicle kilometres, traffic speed, etc. The impact on customer service, e.g., on-time deliveries and costs, should be addressed also at this level;
- *Environmental assessment*: The process involves an analysis of the likely effects on the environment by using indicators such as fuel consumed, pollutants emissions, and freight vehicle related accidents.

1.4 Stakeholders. Several stakeholders may be involved in a city logistics project, each with its own objectives and interest in a possible negotiation. Some may be involved actively in the project and participate to decision making, e.g. shippers and carriers, while others, e.g., citizens, may benefit or suffer from the results of the project and may directly or indirectly (vote) participate. Five items:

- *City*: Always present as an active member in a City Logistics project. Supposed to be a driving and neutral member in the process;
- *Government*: National and regional governments may be very active in problem analysis and encourage the implementation of promising solutions;
- *Shippers and consignees*: Have always been involved in the projects, more present as active member in the process decision lately;
- *Carriers*: Carriers and warehousing companies are usually involved in CLPs;
- *Others*: May participate to the process: e.g., citizens, consultants, universities, etc.

1.5 Project initiator. Traditionally, the City Logistics initiatives were launched by the public sector by leading projects, offering incentives (e.g., financing and regulations), etc. Recently, enterprises are launching CLPs to profit from business opportunities following from new customer needs or emerging priorities in the city. Two items:

- *Public sector*: City council or a government entity;
- *Private sector*: One or group of enterprises.

2. Business model

Any CLP needs to address critical issues related to financing the project and ensure its viability. This criterion provides information on the manner the project is conceived to be build (infrastructure facilities), to operate (operation financing and support), and to be managed (responsibilities). Four criteria are thus used:

2.1 Infrastructure financing.

- *Public*: The government or the city provides the financing to build new infrastructure. The CLPs can also use existing public infrastructure.
- *Private*: Necessary infrastructure is build by the private firms.

2.2 Operation financing. Daily operations can be:

- *Autonomous*: Everyday operations are financially viable for the entire duration of the project;
- *Initial*: An initial and unique contribution to insure a viable start;
- *Unconditional subsidy*: A sum of money is periodically (yearly) granted to help the system function. The sum does not depend on the level of operations;
- *Conditional subsidy*: Participation to the cost of an operation when realized.

2.3 Management defined according to three items:

- Public: The city or a public entity manage the CLP;
- *Private*: The CLP is managed by a private company in an autonomous way;
- *Concession*: In a PPP approach, the city (government) offers to a private company, for a given number of years, the right to use public facilities with fixed common objectives. These objectives condition the contract renewal.

2.4 Competitive advantage describing how the City Logistics system is supported:

- *None*: No distinction between the participating companies in the CLP and the others;
- *Partial advantage*: The participating companies may benefit from specific measures, e.g., longer delivery hours, use of pedestrian areas, use of bus lines, etc.
- *Total*: Participating companies are the unique service providers in the concerned area.

3. Functionality

It describes the main operating principles of the CLP through five criteria:

3.1 Consolidation of the loads of different shippers, consignees, and carriers into the same vehicles is used very often in City Logistic systems. Consolidation takes place at city consolidation/distribution centres (CDCs or UDSs, UCCs) and it can be volunteered on a cooperation basis or imposed by the system configuration. This aspect is described by the *Cooperation* criterion (3.5). Three items:

- *None*: There are no dedicated physical platforms. Pooling information on origins, destinations and products, and managing all the individual requests in an integrated approach allows pick-ups and deliveries to belong to the same routes instead of being parts of many different itineraries;

- *Single-level*: Consolidation takes place at a physical infrastructure from where vehicle routes start to distribute within the city. Several such infrastructures may exist, but loads transit only through one;
- *Two-level*: The two-tier City Logistics concept builds on and expands the CDC and multi-echelon distribution ideas. CDCs form the first level of the system and are located on the outskirts of the urban zone. The second tier of the system is constituted of satellite platforms, where the freight coming from the CDCs and, eventually, other external points may be transferred to and consolidated into vehicles adapted for utilization in dense city zones (see Crainic *et al.*, 2009, for a review).

3.2 Modal shift. Most urban freight transportation issues are linked to the utilization of trucks. The idea is to reduce this impact by transferring part of the freight to other modes:

- *Underground system*: Dedicated or sharing an existing passenger system;
- *Pipeline*: To convey specific commodities in particular areas;
- *Water*: Use of the water channel networks and rivers;
- *Rail*: Use of the heavy or light rail networks for urban freight transport.

3.3 *Regulation* passed by the city to organize and manage freight movements through incentives and restrictive measures:

- *Time windows*: Specific periods for delivery to or transiting through congested areas;
- *Lane and space use*: Permission to use specific arteries (bus lanes) and reserved spaces for loading/unloading/delivery operations;
- *Environmental standards*: Limits of freight vehicle characteristics or impact, e.g., fuel consumption, engine power, emissions, etc.
- *Weight volume/load factor*: To limit access to particular zones;
- *Access charges*: A device used to tackle traffic congestion (also known as *congestion pricing*) and to contribute to improving overall urban mobility. It aims to regulate the demand for urban transport. It may target all vehicles or particular groups only and may be modulated according to the time of day, congestion level, type of vehicle (to account for environmental externalities related to heavy polluters and/or privileged access for low-emitting vehicles), etc.

3.4 Intelligent Transportation Systems (ITS). The core of ITS consists in obtaining, processing and distributing information for better use of the transportation system, infrastructure and services (Crainic *et al.*, 2008). ITS are deployed as interconnected applications using a number of related technologies (communications, computing and decision-support, sensing, etc.). For City Logistics, ITS supports other functional tools, e.g., number-plate recognition, controlled access to Limited Traffic Zones (LTZ), tracking/tracing to better optimize routing operations of cooperating carriers. Four items:

- *ATIS/ATMS*: Advanced Traffic Management System (ATMS) collect real-time traffic conditions, analyze data, predict travel times, manage emergency responses, control traffic-management devices (highway accesses, traffic lights, etc.), and conceive guidelines to be transmitted to the users of the system through Advanced Traveller Information Systems (ATISs). The objective of is to provide the traveller, the vehicle conductor, with better information about the traffic, its problems and breakdowns (e.g., variable message signs announcing travel times or traffic jams), resulting in better driving decisions, fewer miles travelled, less fuel consumed, and less pollution.

- *E-payment and AVI*: For City Logistics, these systems correspond to the electronic payment of tolls or congestion-related fees and Automatic Vehicle Identification (AVI) systems used to control access to LTZ.
- *AFMS*: Carriers interact with the city ATMS/ATIS, and may use the information, together with optimization techniques and algorithms, to better plan the allocation and utilization of the fleet and to efficiently control it in real-time. Such Advanced Fleet Management Systems (AFMS) can significantly contribute to the efficiency and ultimate success of City Logistics systems.

3.5 Cooperation. Cooperative freight transport systems have the potential for achieving many of the aims of City Logistics (Taniguchi *et al*, 1999). Traditionally, carriers were mainly involved but, lately, shippers and consignees are initiating the cooperation. Cooperation is strongly linked to consolidation. Two items:

- *Carriers*: Carrier fleets and customer demands are cooperatively managed;
- *Shippers/Consignees*: Here, the pooling concerns products and destinations. Often, the cooperative system goes beyond transport to others added-value services.

4. Scope

This component classifies the project according to five criteria: *geographic coverage*, *transport modes*, type of *products*, type of *customers*, and *logistics services*.

4.1 Geographic coverage. The CLPs might concern the entire city or a specific area only where congestion and pollution issues related to freight transportation are particularly relevant. We distinguish four items:

- *Corridor*: The concerned area is organized along a major artery in the city;
- *Shared zone*: A delimited zone accessible to all participating carriers;
- *Parcelled zone*: The area is divided into parcels, each serviced exclusively by one or a group of enterprises involved in the distribution process;
- *Town*: The entire city

4.2 Transport mode. For City Logistics, intermodal freight transport, rail/water - road, could lower the pressure on the city streets and decrease the negative environmental impacts. Intermodal terminals are then required as transfer points. Two items:

- *Unimodal*: Road only;
- *Multimodal*: More than one mode.

4.3 Product. Different types of products require different handling, storage conditions, and transporting vehicles. We distinguish two items:

- *Product spec*ific: Fleet and facilities dedicated to the product;
- *Non-product-specific*: Heterogeneous fleet and multi-purpose facilities.

4.4 Customers of CLPs usually are commercial firms or residents. Some projects are however implemented to mitigate the effect of a particular event (e.g., construction site). Three items are therefore considered: *Residents*, *Commercial*, and *Other/Specific*.

4.5 Services. We introduce four items to differentiate the transportation services provided by a particular City Logistics system:

- *Delivery*: Freight movements from outside toward the CL target zone;
- *Pick up*: From the city to the exterior;
- *Delivery and pick up*: Both movements are provided; It also includes movements within the City Logistics zone;
- *Additional* logistics services.

5. Technology

Technology may significantly contribute to a sustainable urban freight transportation system. Technology refers to hardware and software and the intelligence imbedded herein. Three criteria are proposed: the *vehicle* technology used in the project relative to environmental issues; *information and communication* technologies, including intelligent transportation systems; *decision* technology for all project phases to initial design and analysis, to planning, to real-time management of the system.

5.1 Vehicles. Most CLPs encourage the utilization of alternative motorizations to attain the City Logistics objectives. We distinguish three items:

- *Standard*: No specific regulation regarding engines;
- *Low-emission*: The objective is to reduce pollutant emissions (carbon monoxide, hydrocarbons, oxides of nitrogen, and particulate matters). Standards for light commercial vehicles were initiated in the EU in 1993. Among possible approaches: liquefied petroleum gas (LPG) and compressed natural gas (CNG), considered less polluting than the fossil fuels; bio-fuels produced from any carbon source that can be replenished rapidly; hybrid motorizations; etc.;
- *Clean*: Electric or hydrogen-powered vans for urban freight transport or human-powered delivery for short distance links. Today's electric vehicles still suffer from important drawbacks, particularly in energy storage volume and density (and thus driving range and power for freight vehicles), high cost, and low component durability. As for hydrogen, many challenges are still ahead, including distribution.

5.2 *Information and communication.* These technologies are at the core of today's economic and social life, electronic business and ITS, in particular. These are even more important for City Logistics:

- *Internet and EDI.* The Internet is a worldwide interconnected computer networks Electronic Data Interchange (EDI) is a set of standards and procedures for structuring information that is to be electronically exchanged between and within businesses, organizations, government entities and other groups (Crainic *et al*, 2008). These technologies also enable electronic web sites and markets where stakeholders can exchange data and information and participate to the cooperative decision processes;
- *Wireless communications* enable devices to communicate without physical connections and, thus, support mobility and real-time access to information from "anywhere". This technology is present in ITS and City Logistics applications, from short range communications (Wireless Local Area Networks (WLAN) and Dedicated Short-Range communications (DSRC) sys-

tems) to satellite communications used for instance for freight and vehicle localization (GPS, Galileo).

- *Computational technologies*. Advances in computing power (including in the vehicle) allow the efficient processing of complex logistics and transportation planning and operations problems. They support, in particular, the issues addressed in the next criterion, as well as those of the ATMS/ATIS and. AFMS;
- *Sensing technologies* provide bi-directional infrastructure-to-vehicle communication and identification, e.g., inductive loop detection, video vehicle detection, automatic number plate recognition, etc.

5.*3 Decision technologies*. The design, analysis, planning, management, and control of City Logistics systems requires powerful models and methods embedded into decision-support systems (Benjelloun and Crainic, 2008; Crainic *et al.*, 2009). Operations research, simulation, statistics, and econometrics are among the major methodologies supporting this criterion. The three items refer to the main decision levels in complex systems: *Strategic evaluation*; *Tactic exploitation*; *Real-time*.

USING THE TAXONOMY

To illustrate its interest, we use the taxonomy to describe two well-known but different projects. The items characterizing each project are highlighted cells in Figures 2 and 3.

Monaco (Figure 1) represents one of the first experiences in the field. This project had known two major changes during its life, at the management and consolidation levels.

- *Description*: In 1989, the government of Monaco decided to organize the freight movement in the city using an UDC (Frontville platform). The project was evaluated through environmental assessments;
- *Business model*: The infrastructure facilities are owned by the city. From 1989 to 2000, the UDC was managed by a public entity; Since then by a private company under a concession contract. The project benefits from regulation regarding time windows and volume/weight of the vehicles allowed entering the city. Moreover, the city subsidies operations (by parcel transported);
- *Functionality*: A single-level system initially, it moved to a two-level one, using depots in the Parc d'Activités Logistiques at Saint-Isodore;
- *Scope*: The entire town is serviced for all the products except fuels, indivisible loads and special products. The system is also offering some value-added logistic activities.
- *Technology*: Low emission and electric vehicles

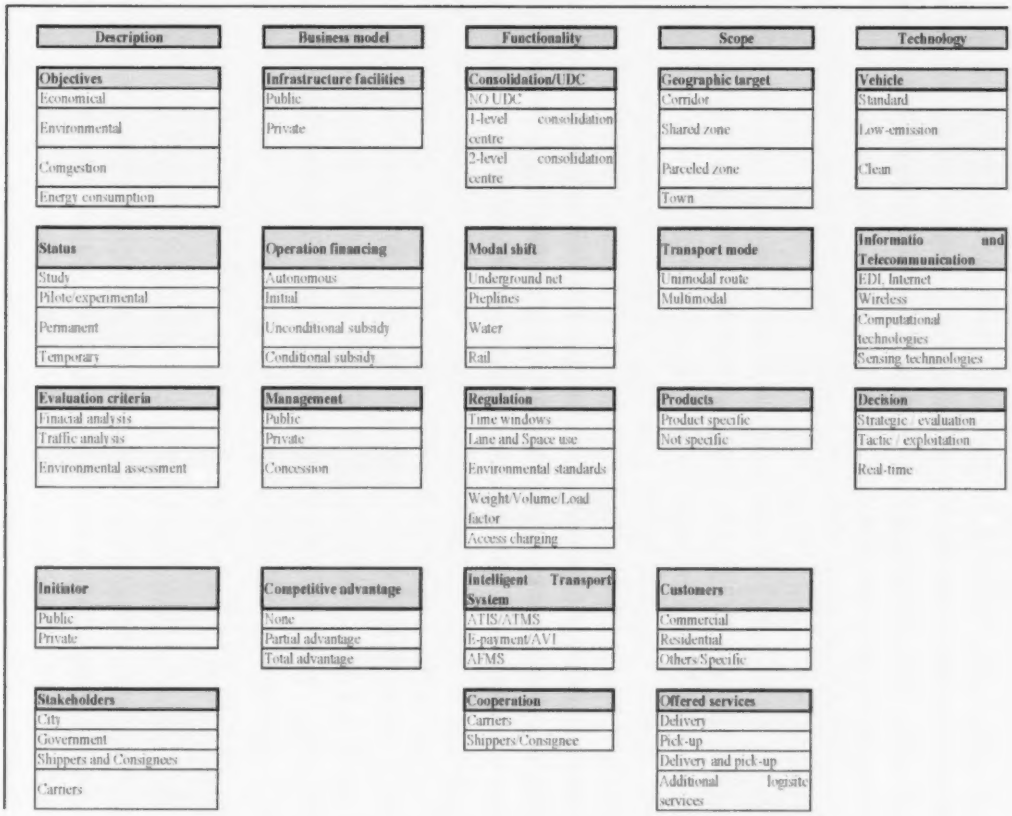

Figure 1. Taxonomy grid for the Monaco CLP

The Amsterdam CityCargo project (Figure 2) is one of the recent CLPs and an example of utilization of alternate transportation modes and of public-private partnership:

- *Description*: After a pilot-project phase, the City Cargo Tram is set to function as a permanent CLP. It is a PPP initiated by the private sector. It aims to reduce pollution by 20% and the number of trucks by half (currently 5,000).
- *Business model*: The infrastructure facilities are city owned and there is no help for the everyday operations.
- *Functionality*: The project currently involves two cargo trams, operating from a distribution centre and delivering to "satellites" (non-passenger tram stops), from where electric trucks deliver to the final destinations. A significant increase in vehicles and facilities is planned.
- *Scope*: The target zone is the inner city of Amsterdam. Bars, restaurants and shops are the main customers and the project is not specific to a type of products.
- *Technology*: Streetcars and electric trucks as vehicles. Optimization of schedules and routes is mentioned but no specifics are available.

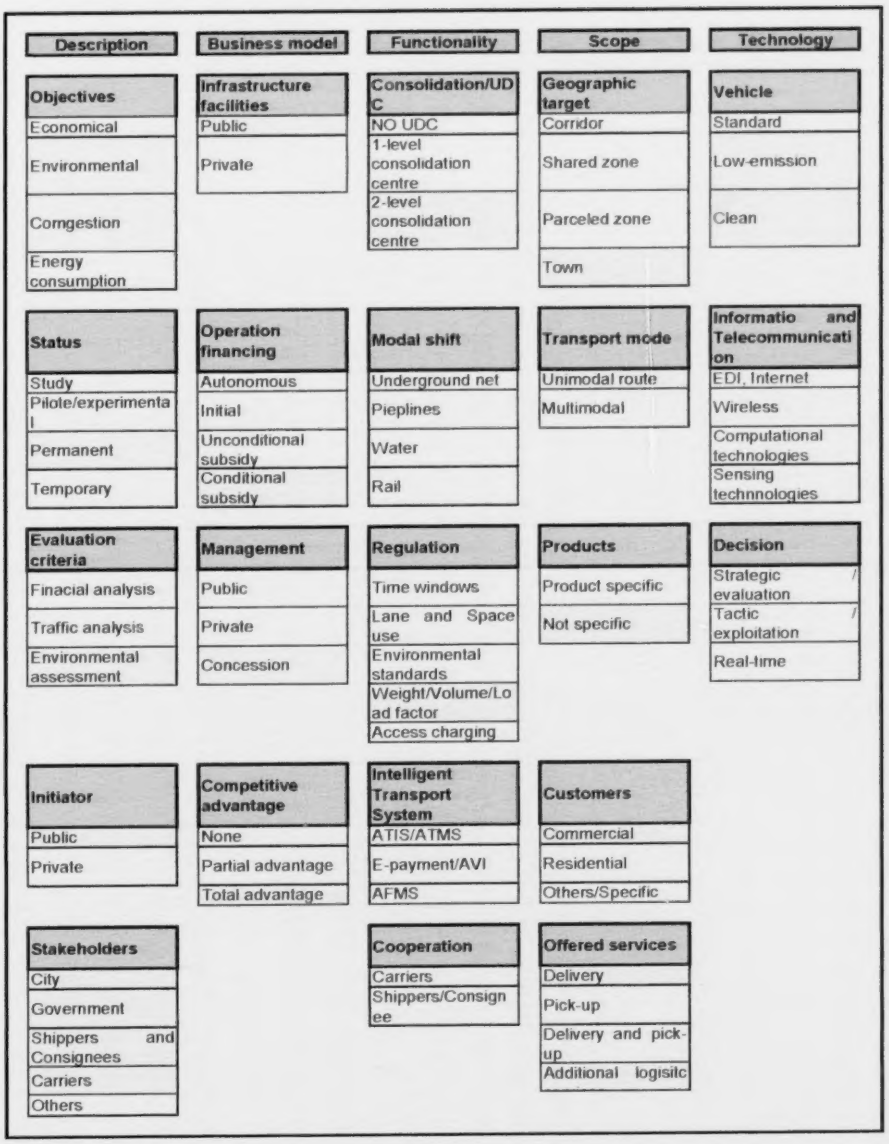

Figure 2: Taxonomy grid for the Amsterdam Cargo Tram CLP

The way City Logistics projects are conceived, evaluated, and managed evolves with the social, political, and technological environment. Innovative ways to organize the physical flow of products through the city may be observed, as well as the increased utilization of alternate modes of transportation. We use to taxonomy and our sample of 70 projects to identify some of these changes and trends (see also Benjelloun and Crainic, 2008). It rapidly becomes obvious that 1) the number of projects is increasing steadily, and 2) projects are undertaken around the world. Table 2 displays the evolution in the number of CLPs, while Table 1 shows the geographical distribution of these projects. The growth of the urban population and the general awareness of ur-

ban freight transport effects on the city and its habitants are the main reasons given in most project descriptions.

Figure 3 details the CLPs objectives over time. As the base number is different from one period to another, we represent each objective as a fraction of the entire set for the period (relative weight). We notice two interesting trends. The first City Logistics initiatives aimed mainly to avoid congestion. Environmental issues appear in the 1990s. Second, by implementing more constraining regulations for urban freight distribution, cities create new business niches for the private sector. In France, for example, private companies are generally involved in the CLPs of the last decade. Actually, cities increasingly allow companies to use public premises (parking, tram networks, bus stations, etc) under constraints of proposing innovative and green schemes. Thus, companies avoid heavy investments and benefit from financially viable projects and the cities can attain their objectives in term of congestion, pollution and energy consumption.

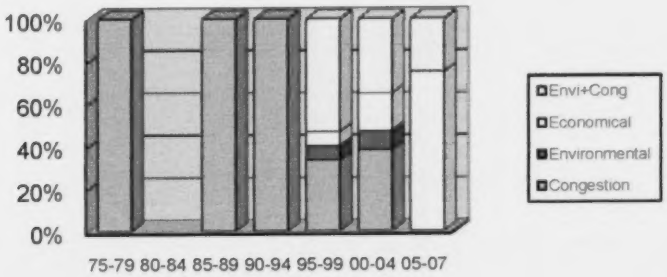

Figure 3. CLPs objectives

Heavy investments regarding CLPs infrastructures make the financial viability more challenging, when reachable. This can explain the evolution presented in Figure 4, where one can see that the private sector is less interested when CLPs require its participation in the infrastructure facility financing.

As mentioned, gathering information on CLPs is very challenging. Even for the projects for which sufficient information was found, it was not complete. For the description component, we had difficulty getting information on evaluation tools, be it for launching the CLP or for measuring its performance. Regarding the business model, the main lack concerned subsidies and who paid what. Functionality and scope were well documented, but only vehicles were generally mentioned regarding the technology. Little information was available on information technologies and almost none on decision technologies. We notice, however, that ITS appears in CLPs from 2000 on. The original City Logistics definition (Taniguchi *et al*, 1999) was actually revised in 2001 (Taniguchi *et al*, 2001) to account for the support of advanced information systems in the process of optimizing logistics and transport activities. Examples of ITS within CLPs include e-payment for city-access charging process, access-control system for restricted zones, and a few web-based applications promoting communication between stakeholders. AFMS is still a challenging area for City Logistics systems, however. To our knowledge, there are no implementations of such management approaches and very few research contributions, e.g., evaluation and

planning of two-tier systems (Crainic *et al*, 2009) and probabilistic vehicle routing and scheduling with ITS (Taniguchi and Ando, 2006).

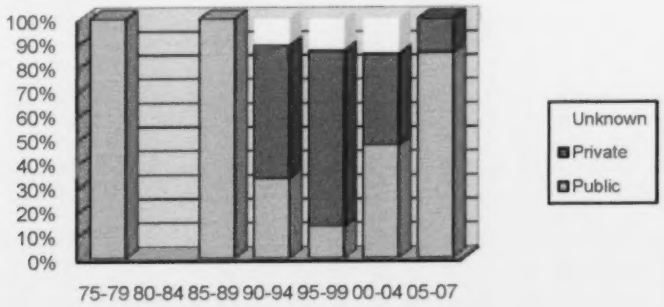

Figure 4. Infrastructure facilities for CLPs

CONCLUSION

We presented a three-layer taxonomy of City Logistics projects that provides the means to explore the similarities and differences in the elements characterizing the various City Logistics initiatives. This contributes toward a better understanding of performances and success factors, which should lead to a better preparation and design of new initiatives. It also provides the means to identify trends in the evolution of City Logistics as well as challenging research directions.

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